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ESTIMATING COST OF REARING DAIRY YOUNG STOCK IN SELECTED FARMS IN MALAYSIA

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

ESTIMATING COST OF REARING DAIRY YOUNG STOCK IN SELECTED FARMS IN MALAYSIA

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April 2022

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Dairy young stock must be readily available in dairy farms to replace culled dairy cows. Proper management practices are crucial to ensure the successful growth of the young stock. However, the dairy young stock does not get optimal attention from dairy farmers because rearing usually takes at least 24 months to generate an income for the farmer. Thus, this study aims to estimate the costs of rearing dairy young stock from birth to the first calving age. First, a questionnaire-based survey was conducted in Keningau, Sabah from July to August 2019 at 13 non-commercials and 1 commercial dairy farm. Secondly, the bodyweight data of individual dairy young stock from the non-commercial farms (n=76) and two commercial dairy farms, each at Sabah (n=150) and Johor (n=73) were collected and analysed. The Gompertz function, W (t) = A * Exp (-B * Exp (-K * t)), was used to predict the bodyweight of the dairy young stock. The survey results and the bodyweight data were summarized in Microsoft Excel and were analysed using Statistical Package for Social Science (SPSS) version 25.0 (IBM). Finally, a stochastic bio-economic model at animal level was developed in Microsoft Excel (Microsoft Corp. Redmond, WA, USA) using @Risk add-in software (Palisade Corporation, Ithaca, NY, USA). Inputs for the model were based on chapter 3 and 4, literature and expert opinion. The survey results showed the average first calving age were 35 ± 1.48 months and 24 months in non-commercial and commercial dairy farms, respectively with an average cost of rearing of RM4,320 per heifer which only include cost of milk and concentrate. The average first calving weight of dairy young stock predicted using the Gompertz model was 430kg across different farm management system. The stochastic bio-economic model estimated the average total cost to rear a dairy young stock from birth until first calving age across different farm management systems is RM7,681.15 per heifer including the average mortality cost of RM2.65 per survived heifer. In conclusion, the results of this this study have revealed differences in the first calving age and costs of rearing dairy young stock amongst non-commercial and commercial dairy farms in Malaysia.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

ANGGARAN KOS PEMELIHARAAN DARA GANTIAN LEMBU TENUSU DI LADANG TERPILIH DI MALAYSIA

Oleh

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Pengeluaran dara gantian lembu tenusu diperlukan bagi menggantikan lembu tenusu yang telah mati supaya ladang tenusu dapat meneruskan operasi. Amalan pengurusan yang betul adalah penting untuk memastikan pertumbuhan anak lembu berada di dalam keadaan baik. Akan tetapi, dara gantian lembu tenusu biasanya tidak mendapat perhatian optimum daripada penternak lembu tenusu kerana penternakan dara gantian lembu tenusu mengambil masa sekurang-kurangnya 24 bulan untuk menjana pendapatan kepada penternak. Oleh itu, kajian ini bertujuan untuk menganggarkan kos penternakan dara gantian lembu tenusu dari lahir hingga umur beranak kali pertama. Pertama, tinjauan menggunakan borang soal selidik telah dijalankan di Keningau, Sabah dari Julai hingga Ogos 2019 di 13 ladang bukan komersial dan 1 ladang komersial. Kedua, data berat badan individu dara gantian lembu tenusu daripada 13 ladang bukan komersial (n=76) dan dua ladang komersial di Sabah (n=150) dan Johor (n=38) telah dikumpul dan dianalisis. Fungsi Gompertz, W (t) = A * Exp (-B * Exp (-K * t)), telah digunakan untuk meramal berat badan anak lembu tenusu. Hasil tinjauan dan data berat badan anak lembu diringkaskan dalam Microsoft Excel® (Microsoft Corp. Inc, Ithaca) dan dianalisa menggunakan IBM SPSS Versi 25. Akhirnya, model stokastik bio-ekonomi pada peringkat haiwan telah dibina dalam Microsoft Excel (Microsoft Corp. Redmond, WA, USA) menggunakan perisian tambahan @Risk (Palisade Corporation, Ithaca, NY, USA). Input model adalah daripada bab 3 dan 4, literatur dan pendapat pakar. Hasil tinjauan menunjukkan purata umur beranak kali pertama ialah 35 ± 1.48 bulan dan 24 bulan di ladang bukan komersial dan ladang komersial, secara berikutan dengan kos purata RM4,320 untuk seekor dara gantian lembu tenusu dimana hanya melibatkan kos susu dan konsentrat. Purata berat badan dara gantian lembu tenusu semasa umur beranak kali pertama yang diramal menggunakan model Gompertz ialah 430kg merentasi sistem pengurusan ladang yang berbeza. Model stokastik bio-ekonomi menganggarkan purata kos menternak seekor dara gantian lembu tenusu dari

lahir sehingga umur beranak kali pertama ialah RM7,681.15 termasuk purata kos kematian berjumlah RM2.65 untuk seekor dara gantian lembu tenusu yang hidup. Kesimpulannya, hasil kajian ini telah mendedahkan perbezaan antara umur beranak kali pertama dan kos menternak seekor dara gantian lembu tenusu dalam kalangan ladang bukan komersial dan ladang komersial di Malaysia.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

AHE	Animal Health Economics
AI	Artificial Insemination
BCS	Body Condition Score
CMR	Calf Milk Replacer
CS	Calf Starter
DCP	Dairy Cattle Pellet
DM	Dry Matter
DVS	Department of Veterinary Services
FAO	Food and Agriculture Organization
FCA	First Calving Age
GDP	Gross Domestic Production
HHP	Herd Health Programme
LID	Local Indian Dairy
MAFI	Ministry of Agriculture and Food Industries
MBW	Mature Body Weight
MCO	Movement Control Order
MJ	Megajoule
MyGAP	Malaysian Good Agricultural Practice
NLDP	National Livestock Development Programme
NS	Natural Service
PKC	Palm Kernel Cake
SDFA	Sabah Dairy Farmer Association
SSL	Self-Sufficiency Level
TMR	Total Mixed Ration

UK	United Kingdom
USA	United State of America

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background of the study

Dairy farming is a common source of good income occupation in developing countries (Britt *et al.,* 2018). In Malaysia, there are 742 dairy farms where most dairy farm owners (77%) are non-commercial in year 2020 (DVS, unpublished data). As demand for dairy products in Malaysia continues to rise, the local fresh milk production needs to keep up. The current self-sufficiency level (SSL) of fresh milk production in Malaysia has decreased from 114% (2012) to 64% (2020) but there was an increasing trend starting from 2017 (DVS, 2021a). The country has a huge potential for the development of the dairy industry where a significant effort to increase the production of milk and dairy products has been made through the National Livestock Development Programme (NLDP). The aim of NLDP is to achieve 100% SSL of fresh milk production by increasing the herd size and ensuring economic sustainability for dairy farms by 2025.

In dairy farms, the availability of dairy young stock is necessary for the sustenance of dairy farms. A farm is made up of three main enterprise which are the land enterprise produces feed and manages the waste of the animals, the dairy cow enterprise which produced milk and culled dairy cows and the young stock enterprise manages the new-born heifer calves to provide high-quality replacement heifers (Boersema et al., 2010; Mohd Nor et al., 2012) and to increase the herd size (De Vries, 2017). The young stock enterprise is a long-term investment other than land and dairy cows' enterprise. Young stock rearing is also one of the key high-cost enterprise which contributes 13% to the cost price of milk in the dairy farm (Mohd Nor et al., 2012). Dairy farmers need to understand the scientific principles of calf growth, nutrition, health, behaviour, and cost to increase calf weight gain in later stages, promote early oestrus of the heifer, improve herd health, and reduce young stock rearing costs (Moran, 2012a).

High milk producing and high milk exporting countries such as the United States and The Netherlands have studied young stock rearing cost estimation (Heinrichs et al., 2017). According to previous studies, the total costs of rearing young stock in The Netherlands is RM7,713 (Mohd Nor *et al.,* 2012) and RM9,213 in the US (Karszes, 2014a). The input costs include feed, housing, labour, health, reproduction, bedding, facilities, equipment, mortality, and interest (Gabler *et al.,* 2000; Mohd Nor *et al.,* 2012; Heinrichs *et al.,* 2013). Cost estimation evaluates various consumptions in the production process, analyses the reasons for various consumption and cost increases and decreases, and finds ways to reduce costs and improve economic benefits. However, the cost

of rearing young stock varies between farms, depending on the individual management strategy in practice (Boulton *et al.,* 2017; Hawkins *et al.,* 2019).

1.2 Statement of Problem

The process of rearing dairy young stock is expensive and difficult to be estimated because of its complexity due to variation in prices (e.g., feed price) and management practices. The lack of information on financial will lead to difficulty in estimating the cost of rearing dairy young stock. The financial statements such as balance sheet, income statement and cash flow statement were crucial to get the financial information.

Secondly, uncertainty such as mortality occurs in the process of rearing dairy young stock leading to difficulty in estimating economic losses. Information on the mortality rate needed to estimate the loss on dairy farm. The economic loss due to mortality is difficult to estimate due to lack of record keeping on the farm management such as the number of dead and number of births of dairy young stock. The majority of the non-commercial did not aware on the costs of rearing dairy young stock which consequently, making the estimation of losses due to mortality very difficult.

The estimation of costs of young stock rearing is related with the growth performance of dairy young stock with adequate bodyweight. In the current situation, 77% of dairy farmers in Malaysia are non-commercial without a weighing facility in the farm to monitor the young stock. Weighing the young stock which could be due to weighing was perceived as an unnecessary chore and could be laborious. This causes the farmer unable to estimate the amount of feed accurately and make correct decisions on the farm. Consequently, farmers are unable to realize that high-quality heifers will return their investment from higher bodyweight, better milk yield and higher longevity. This research is designed to estimate the cost of rearing dairy young stock in Malaysia by using a stochastic bio-economic model which can include variation and uncertainty.

1.3 Research Justification

A proper understanding of dairy young stock rearing costs is beneficial for strengthening the enterprise as it is an important investment for the future on a dairy farm. The cost of rearing young stock is a key performance indicator of a young stock enterprise that can be used by dairy farmers for major management decisions so that they will be able to adjust their young stock management practices and make the rearing period more efficient. Moreover, estimating the cost of rearing dairy young stock can provide useful insights for different stakeholders such as both new and existing farmers, government, support agencies, academicians, and veterinarians in the industry to come up with an

advisory guideline on better choices in planning regarding the rearing of dairy young stock.

In 2020, there are a total of 742 dairy farms in Malaysia and 55 dairy farms (7.4%) in Sabah (unpublished data). This study was chosen to be conducted in Keningau, Sabah as all types of farm management systems (non-commercial and commercial farm) exist which enable us to compare the total cost of rearing dairy young stock in different farms management systems. In addition, dairy farms in Keningau contribute the highest milk production in Sabah's milk production (90.6%) compared to the other district (DFAS, unpublished data) as dairy farms in Keningau has more well-established facilities such as milking machines including in the non-commercial farms. Previous study reported that 70% (n = 21) of the dairy farmers in Keningau with better education, larger herd size, high production level, showed a better understanding and had satisfactory-to-good knowledge in dairy cattle welfare (Sadiq *et al.,* 2021). We believe that farmers with good knowledge could increase the accuracy in the calculation of the total cost of rearing dairy young stock.

When evaluating the profitability and productivity of dairy farm operations, it is critical to understand the cost of rearing heifers. The young stock rearing in the Malaysian dairy industry has not yet been economically analysed using a stochastic model based on the author's knowledge. Dairy farm competitiveness can only be improved by getting insights in the costs of rearing, and the costs can be estimated by using a stochastic bio-economic model.

1.4 Research Questions

The main research question of this study is:

What is the total cost of rearing dairy young stock in Malaysia?

1.5 Research Hypothesis

H_0: Different farm management practices determine the variable cost of rearing dairy young stock.

H_1: Different farm management practices do not determine the variable cost of rearing dairy young stock.

1.6 Objectives of the study

This study aims to estimate the costs of rearing dairy young stock from birth to the first calving age on dairy farms.

The specific objectives of this study include:

1) To determine the management practices and the costs of rearing of different farm management systems
2) To analyse the growth performance of dairy young stock from birth to first calving age in different farm management systems
3) To estimate costs of rearing dairy young stock from birth to first calving age that includes uncertainty in mortality

1.7 Terms and Definition

Dairy farms in Malaysia were categorized based on the number of dairy cows on the farm as non-commercial and commercial farms (Arumugam & Karim, 2018; Suntharalingam, 2019). In this study, we defined each category as follow:

1.7.1 Non-commercial farm

A dairy farm with less than 50 dairy cows was classified as a non-commercial farm.

1.7.2 Commercial farm

A dairy farm with more than 50 dairy cows was classified as a commercial farm.

1.7.3 Stochastic bio-economic model

A model that estimated the cost of rearing includes uncertainty in mortality of dairy young stock.

1.7.4 Uncertainty in mortality

An unpredictable loss of dairy young stock due to sudden death from disease, environmental or genetic factors. This can happen at any time while rearing dairy young stock and cause considerable economic losses in terms of the inputs and time lost in producing one calf per cow per year.

1.7.5 Variation

A change or a slight difference in the condition such as growth performance in dairy young stock and market price (e.g., feed, wages).

1.7.6 Variable cost

Costs that are directly related to the number of variable inputs, such as feed, labour, and reproduction costs.

1.8 Research Overview

The modelling process of rearing a dairy young stock includes uncertainty in mortality is shown in Figure 1. In Malaysia, dairy young stock rearing is expensive, and the costs of rearing is difficult to be estimated because of its complexity due to variation and uncertainty. Modelling was built to estimate the cost of rearing from birth to first calving age. Firstly, by making the assumptions, secondly constructing the model in Microsoft Excel using @Risk, thirdly by parametrizing the model using biological and economics inputs, fourthly by interpreting outputs and finally by validating outputs of the model and refining the model where necessary. The stochastic bioeconomic model developed assumptions such as milk was restricted to 10% of the pre-weaning calf live weight, solid feed was based on 3% of dry matter intake for post-weaning heifer, the animal was assumed breed through AI (unsexed semen) and successfully bred after the first insemination with 270 days of gestation, the oestrus detection and conception rates were not included in the model, the record of disease outbreak was not included, but the uncertainty of mortality was included from birth to first calving age. The stochastic bioeconomic model was built by including the cost of feed, labour, breeding, and mortality. The biological and economic inputs used in the stochastic bioeconomic model (chapter 5) were from the Chapter 3 and Chapter 4, literature, and expert opinion. The model output was interpreted as the total cost of rearing include uncertainty of mortality. Survey results (chapter 3) and expert opinion were used to validate the model output. Model was refined to reflect the situation of dairy young stock enterprise on dairy farms in Keningau, Sabah.

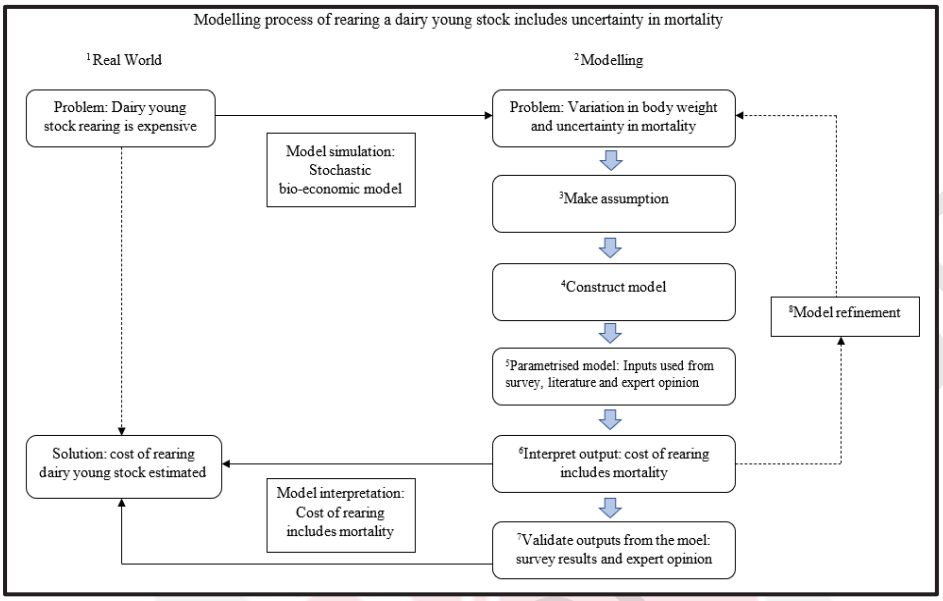

Figure 1.1 : An overview of the stochastic bioeconomic model used to estimate the total cost of rearing dairy young stock from birth to first calving age

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